

Biology of the conger eel *Conger oceanicus* in the Mid-Atlantic Bight

I. Distribution, age, growth and reproduction

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Abstract

Conger oceanicus sampled in 1980 to 1983 from the tilefish longline fishery in Mid-Atlantic and southern New England regions of the USA were supplemented with inshore samples caught by small-meshed trawl. The total lengths (TL) of conger eels caught by longline were larger (48 to 123 cm TL) than eels taken by trawl (18 to 67 cm TL). Because males were smaller than all but the smallest females seen in the fishery (<50 cm TL), the absence of males from the offshore longline catch was attributed to gear selection. Conger eel catch rates in the longline fishery were highest in winter. Otoliths were used to age conger eels and to determine back-calculated length at age. Validation of annulus formation was difficult because a multiple banding pattern occurred and otolith shape was variable. The otolith data indicated that size at a given age was highly variable. Gross morphologies of the gonads were similar to those described for *Anguilla* spp. Ovaries had "frills" on the distal surface and gonidia >20 µm in diameter in histological sections. Males were distinguished by the presence of gonidia in well-defined crypts. Female ovaries were characterized by having either oocytes in a previtellogenic condition, or oocytes undergoing vitellogenesis together with adipose cells. In females >85 cm TL, the most mature individuals (those having a high gonosomatic index and mean maximum oocyte diameter) occurred during the late spring and early summer. The absence of ripe or spent female conger eels in Mid-Atlantic and southern New England regions suggests that they leave the region to spawn, probably in the Sargasso Sea.

Introduction

The range of the conger eel *Conger oceanicus* is from Massachusetts to Florida and extends into the Gulf of Mexico as far as west as Mississippi (Bigelow and Schroeder 1953,

Kanazawa 1958). This species occurs from shallow coastal waters to the edge of the continental shelf at depths up to 262 m (Bigelow and Schroeder 1953). Leptocephali have been encountered on occasion as far north as the Gulf of Maine (Jackson 1953, Hauser 1975) and off Nova Scotia (Leim and Scott 1966). Large conger eels have been observed sharing the burrows of tilefish (*Lopholatilus chamaeleonticeps*) in Hudson Submarine Canyon (Able et al. 1982), and under boulders and in burrows excavated into walls of Veatch and Lydonia Submarine Canyons (Grimes et al. 1986).

Information on the early life history of *Conger oceanicus* is limited. Eigenmann (1902) identified *C. oceanicus* eggs collected near Nantucket Lightship. However, these were probably the eggs of the margined snake eel *Ophichthus cruentifer* (Naplin and Obenchain 1980). Schmidt (1931) believed that *C. oceanicus* spawned in an area east of the West Indies – a belief based on collections of the smallest larvae in this region. Leptocephali appear in coastal and estuarine regions from Chesapeake Bay north between May and August (Hardy 1978) and reach a maximum length of 160 mm before metamorphosis. After metamorphosis, the resultant elver is 90 to 100 mm long (Bigelow and Schroeder 1953, Hardy 1978). *C. oceanicus* reaches a maximum size of 2 m TL and a weight of 8 kg (Bigelow and Schroeder 1953).

Conger eels are a common component of the outer continental shelf fish fauna, as evidenced by its abundance in the New Jersey longline fishery for tilefish and by observations from submersibles (Able et al. 1982, Grimes et al. 1986), yet very little is known about its life history. Here we report on the size structure, catch per unit effort, age and growth, and the reproductive biology of *Conger oceanicus* taken from the Mid-Atlantic Bight.

Materials and methods

Conger oceanicus specimens were obtained from the New Jersey longline fishery for tilefish and by small-meshed

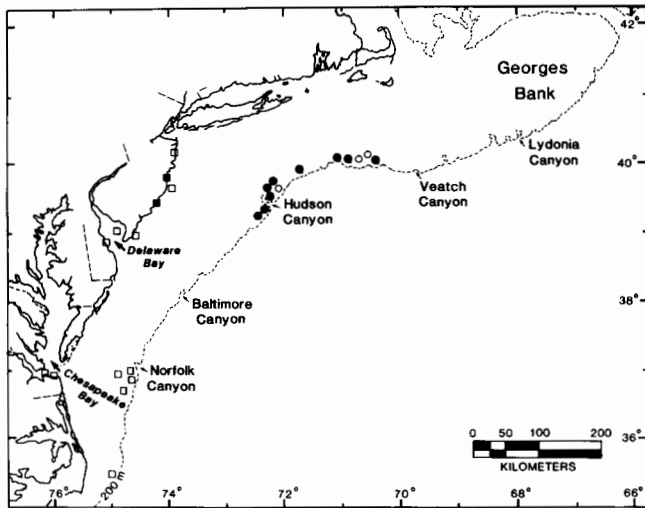


Fig. 1. *Conger oceanicus*. Sample locations for eels collected by longline (circles) or trawl (squares). Open circles and squares indicate locations from which individuals were examined for food habits by Levy et al. (1988)

trawls in coastal waters and the Norfolk Submarine Canyon region (Fig. 1). This longline fishery operates in the Mid-Atlantic Bight from Hudson Submarine Canyon north to Hydrographer Submarine Canyon at depths of 100 to 260 m (Grimes et al. 1980). *C. oceanicus* were sampled on four seasonal cruises on longline fishing vessels in February, May, August, and November 1982 and by port sampling at Barnegat Light, New Jersey, from April, 1980 to March, 1983. Samples captured by small-meshed trawl were obtained from various museum collections. Size structure of conger eel collections was examined using total length (TL) frequency histograms. Mean catch per unit effort was calculated for each seasonal cruise in kg/tub (one tub is approximately 250 hooks on 0.8 km of longline gear).

For age and growth analysis, we removed both sagittal otoliths from 548 fresh specimens and stored them dry in labeled envelopes. We examined otolith banding patterns to determine age. Total weight of the left otolith was recorded and the right otolith was sectioned with a diamond saw at 0.375 mm intervals through the center in a transverse plane perpendicular to the long axis of the otolith (Fig. 2). Sections were mounted on a glass microscope slide with a thin layer of Permunt and examined for banding patterns under a binocular dissecting microscope at 40× with transmitted light to detect annuli. A drop of 95% ethanol was placed on the sections to enhance the appearance of rings.

The section passing through the otolith center had the most defined nucleus and the largest radius for the first annulus. An ocular micrometer was used to measure the distance from the center of the otolith to the outside edge of each opaque ring and to the edge of the otolith along a line from the center to the dorsal ridge of the sulcus (Fig. 2, Axis A). Measurements were made to the outside

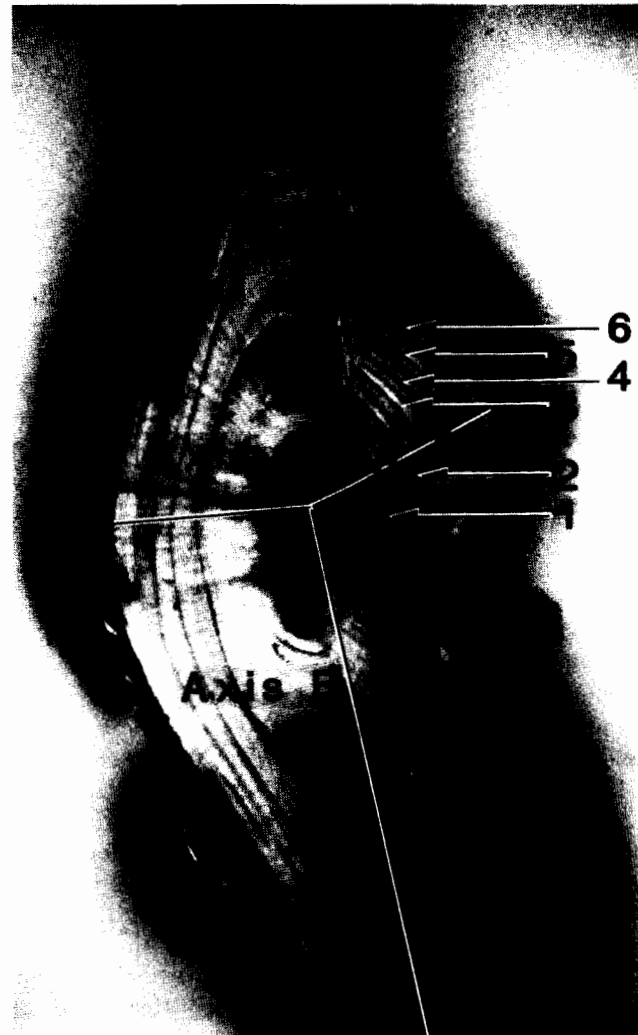


Fig. 2. *Conger oceanicus*. Transverse section (0.375 mm thick) from the right sagittal otolith of with six annuli. Three axes are shown: Axis A from the center to the dorsal ridge of the sulcus, Axis B from the center to the ventral edge, Axis C from the center to the distal edge

of each opaque band because the transition to the next translucent band was comparatively distinct. Each otolith was read three times and if two of the three readings did not agree, the otolith was read a fourth time. One year was added to the number of annuli present to account for the leptocephalus stage of development (Helfman et al. 1984).

In an attempt to validate the annual deposition of rings in the otolith, the following were determined: the relationship between fish length and otolith size, the distance from the center of the otolith to each annulus, and the marginal increment (the distance between the last annulus and the edge of the otolith). Because of high variability in the relationship between otolith radius and fish length, the distances from the center to the edge of the otolith along two other axes were also recorded (Fig. 2, axes B and C). To examine growth, length at age was calculated using a

regression of total length on otolith radius (Ricker 1973, Bagenal and Tesch 1981).

Gonads from fresh and preserved specimens were used to study reproductive biology. The gonads obtained by port sampling ($n=281$) and seasonal cruises ($n=157$) were removed, fixed in 10% formalin, and transferred to 70% ethanol. Before preservation, gonads from port samples were weighed to the nearest 0.1 gm. Specimens collected by trawl ($n=76$) were preserved whole before the gonads were removed. Gonads were examined histologically for development of the gonad and to determine sex. Samples were originally taken from anterior, medial, and posterior locations in the gonad, but because there were no differences in oocyte development, a single sample was used from the center of either the right or left gonad. Samples were dehydrated, embedded in paraffin, and sectioned at 7 μm . Sections were stained in Gill's or Harris' hematoxylin and counterstained with eosin (Thompson 1966). Each slide was examined with a compound microscope at 100 \times to determine the sex. A gonosomatic index was calculated as the ratio of gonad weight to gutted body weight multiplied by 100. Oocyte diameters were measured with an ocular filar micrometer and a mean maximum oocyte diameter (MMOD) was calculated as the average of the ten largest oocytes in a histological section.

Results

Distribution, size structure, and abundance

Conger oceanicus taken by longline were collected at depths of 120 to 260 m and were generally larger (48 to 123 cm TL) than those collected by trawl (18 to 67 cm TL; Fig. 3). Based on the catch from seasonal cruises, 62% were between 60 to 80 cm TL. Full recruitment into the fishery did not occur until 70 to 75 cm TL (Fig. 3A). Seasonally, catches over the winter, spring, summer, and fall showed very similar peaks in their distributions centered between 65 and 80 cm TL. Mean catch per unit effort was highest in February (4.0 kg/tub; range=1.5 to 8.5) and lowest in August (0.5 kg/tub; range=0.0 to 0.8). Mean catch per unit effort for the May and November seasonal cruises were 1.3 kg/tub (range=0.4 to 2.8) and 0.8 kg/tub (range=0.0 to 2.3) respectively.

Conger oceanicus collected by small-meshed trawl were mostly from inshore locations. Of 94 eels examined, 75 were caught in Chesapeake Bay, Delaware Bay, or in New Jersey estuaries (Fig. 1). Eight more were caught in the vicinity of Norfolk Canyon and off Cape Hatteras in depths of 43 to 250 m. One individual was collected off Pensacola, Florida.

Age and growth

Otoliths from 193 individuals captured by the New Jersey longline fishery were examined for aging purposes. A G-

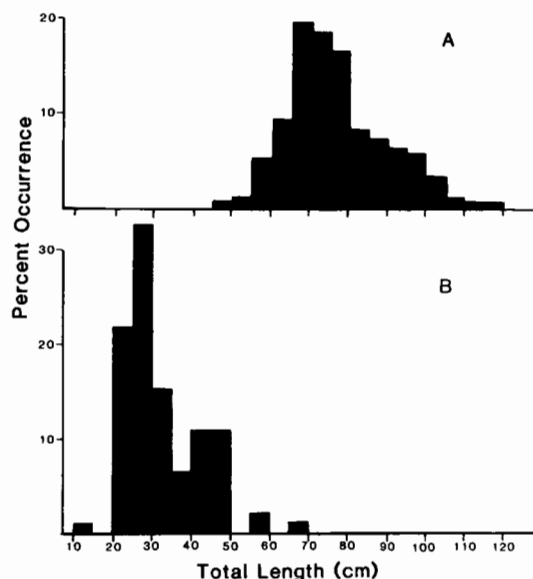


Fig. 3. *Conger oceanicus*. Length frequency distributions: A: random subsample of conger eels collected by longline ($n=699$); B: specimens collected by trawl ($n=94$)

test for goodness of fit (Sokal and Rohlf 1980) showed the size distribution of the fish used for age and growth analyses did not significantly differ from the size distribution of the fishery ($P < 0.05$). The banding pattern in the otoliths is shown in Fig. 2. Under transmitted light, the nucleus appeared dark with alternating translucent (clear) and opaque (dark) rings radiating outward. Often the opaque rings comprised multiple bands that converged in the region of the sulcus. Of the otoliths examined, rings were counted in 161 (83%), and 136 (70%) were clear enough to measure the distance to each band.

Validation of the annual deposition of opaque and translucent rings in the otolith proved difficult. As fish length increased, so did the number of rings in the otolith (Table 1), the weight of the otolith (OW), and the otolith axes. The geometric functional regressions of total length (mm) to otolith weight (g) was:

$$\ln TL = 0.5996 \ln OW + 8.6335; r = 0.76 \text{ and } n = 214.$$

Axis A (Fig. 2) was:

$$\ln TL = 0.8598 \ln \text{Axis A} + 0.1296; r = 0.57 \text{ and } n = 193.$$

Axis B (Fig. 2) was:

$$\ln TL = 1.6005 \ln \text{Axis B} - 4.0086; r = 0.53 \text{ and } n = 216.$$

Axis C (Fig. 2) was:

$$\ln TL = 1.3597 \ln \text{Axis C} - 0.9744; r = 0.18 \text{ and } n = 217.$$

Intervals for the first few annuli show consistency in the ring spacing among ring groups (Hood 1985). For all age groups, the first annulus was laid down 1.10 to 1.30 mm from the center of the otolith, the second at 1.50 to 1.75 mm, and the third at 1.90 to 2.20 mm. From the

Table 1. *Conger oceanicus*. Mean back calculated length (cm) at age for each annulus, weighted mean back calculated length and increment, mean empirical length at age, and weight increment (gm) for eels caught by longline from the Mid-Atlantic Bight. Range is in parenthesis

Age (yr)	n	Annulus											
		1	2	3	4	5	6	7	8	9	10	11	12
3	5	33 (29–37)	51 (44–54)										
4	20	29 (23–40)	45 (33–62)	58 (44–75)									
5	25	30 (20–48)	43 (28–66)	57 (41–84)	67 (48–102)								
6	23	29 (21–38)	42 (31–56)	53 (41–69)	64 (47–85)	73 (53–98)							
7	25	28 (20–34)	41 (30–53)	53 (42–70)	62 (49–81)	71 (55–88)	79 (62–100)						
8	19	29 (22–40)	41 (33–55)	51 (38–67)	62 (48–83)	71 (55–94)	79 (63–100)	86 (70–108)					
9	11	26 (22–29)	36 (26–43)	46 (36–56)	56 (42–70)	64 (48–75)	72 (57–83)	79 (65–87)	86 (71–96)				
10	4	26 (20–28)	31 (26–33)	40 (32–49)	48 (38–60)	57 (51–68)	67 (61–74)	76 (67–86)	84 (73–101)	91 (78–109)			
11	1	26	34	42	46	57	64	70	78	83	86		
12	2	22	29	36	46	57	63	67	78	86	91	99	
13	1	21	25	31	38	45	54	61	69	79	83	93	101
Weighted mean		28	40	51	60	68	75	75	83	86	88	99	101
Increment		12	11	9	8	7	0	8	3	2	11	2	
Age (yr)			3	4	5	6	7	8	9	10	11	12	13
Empirical length (cm)			61 (55–68)	67 (48–75)	73 (52–113)	80 (59–108)	82 (66–108)	93 (75–112)	92 (77–105)	99 (85–118)	91 (103–105)	104	106
n			5	28	32	27	29	18	17	6	1	2	1

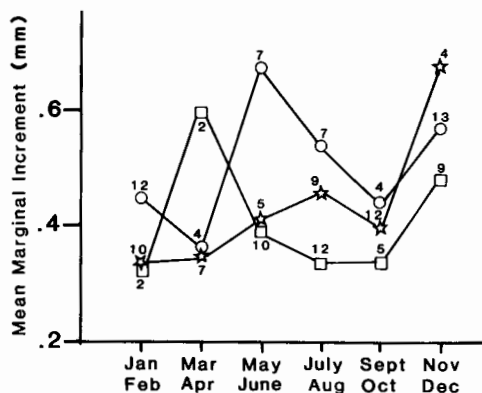


Fig. 4. *Conger oceanicus*. Bimonthly mean marginal increments in otoliths from 3 to 5 (circles), 6 to 7 (stars), and 8+ (squares) year old fish taken in the Mid-Atlantic Bight by longline

fourth annulus on, however, the curves became flatter and tended to overlap more.

Rings appeared to be laid down during winter, but the analysis is equivocal (Fig. 4). All the age groupings showed an increase in mean marginal increment between Septem-

ber and December. In otoliths with less than four rings, another peak occurred during the May/June interval, and for otoliths with more than seven rings, an additional peak occurred during the March/April interval. Because of wide-ranging values of variance and sample size, a Kruskal-Wallis non-parametric analysis of variance was used to compare means. There were no significant differences ($P < 0.05$) between the monthly means for each age grouping, presumably due to extremely high within-group variance. However, since all age groupings show an increase from September to November, it is possible that the translucent zone is laid down at the end of this period.

If we assume that a single ring is laid down each year, the age of conger eels taken by longline was 3 to 13 yr (Table 1). Although mean back-calculated length and mean empirical length did increase with age, length at age was variable. For any given age group, the size range overlapped the size range of the preceding and following age groups (Table 1). This variability might be attributed to different growth rates or the low correlation between otolith radius and total length (the basis of back calculations of length at age). Increases in length during the first several years were similar but became erratic in older fish

(Table 1). From ages 2 to 7, length increments decreased from 12 to 7 cm yr⁻¹. In older fish the increments were generally smaller.

The length:weight relationship was examined using both untransformed and transformed data. The best correlation was obtained by using natural logs, and the resultant regression line was

$$\ln WW = 3.46 (\ln TL) - 8.28 (r^2 = 0.95),$$

where WW is whole weight in g and TL is length in cm. Converting weighted mean length at age to weight reveals that weight increases exponentially for the first few years from 33 g between Ages 2 and 3 to 224 g between Ages 6 and 7 (Table 1). After this point, sample size was smaller and the weight increments fluctuated.

Reproductive biology

Sex determination

Gross structure of gonads from males and females (both fresh and preserved) are very similar. The gonads are flat, white, paired structures which run the length of the body cavity and extend past the anus. They are attached to the peritoneum on either side of the swim bladder. One feature that helps to distinguish females from undifferentiated individuals and males is the presence of "frills" on the distal side of the ovary. In small *Conger oceanicus* (<30 cm TL), the gonads are threadlike and too small to sex macroscopically.

Histologically, testes and ovaries first became distinguishable in conger eels 25 to 40 cm TL. Females were identified by the presence of oocytes, defined as gonia >20 µm in diameter (Fig. 5). Males and undifferentiated individuals were more difficult to identify because the gonia were <10 µm in diameter. If the gonia were obviously clustered in crypts, however, then the gonad was considered a testis (Fig. 6). Gonad sections from some *Conger oceanicus* had no recognizable gonia, but instead had striations that stained strongly with eosin. These individuals were probably females because the gonads had the "frills" of an ovary and because striations were seen in other gonads that contained oocytes.

Sex ratio

Males and undifferentiated individuals were found only in trawl collections (Table 2). Of the males examined, only two (48 and 49 cm TL) approached the size range of the specimens taken by longline. Male and female specimens taken by trawl were found in samples from coastal waters and at depths up to 200 m in Norfolk Submarine Canyon. Females were found in both trawl and longline collections (Table 2).

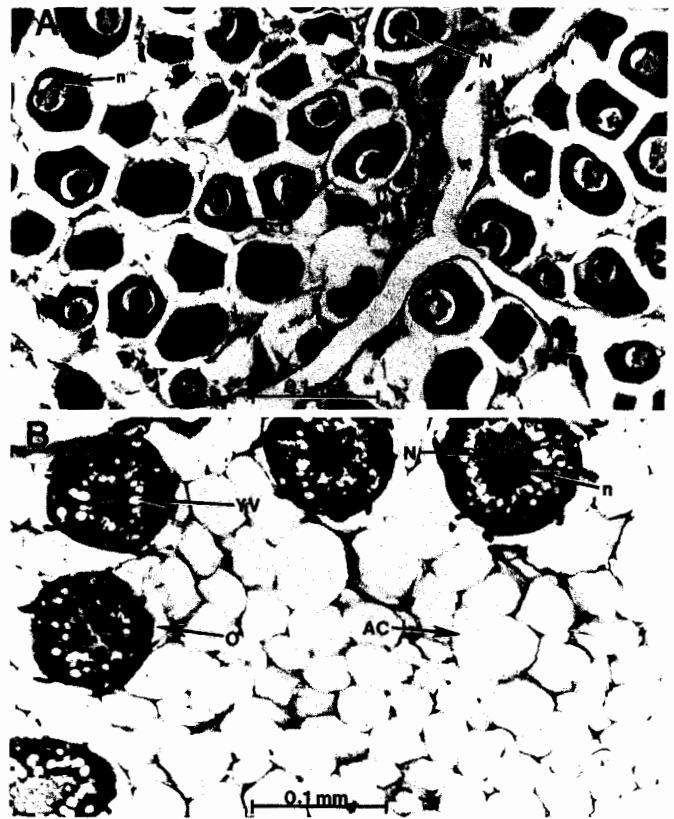


Fig. 5. *Conger oceanicus*. Ovarian sections A: Cross section through the ovary of a 76 cm TL female with the oocytes (O) in a pre-vitellogenic condition; B: Cross section through a more advanced ovary from a 87 cm TL individual with vitellogenic oocytes. Oocytes are within an adipose matrix (A). AC: adipose cell; N: nucleus; n: nucleoli; O: oocyte; YV: yolk vesicle

Table 2. *Conger oceanicus*. Sex ratio of eels taken by longline and from trawl collections. Size range (cm TL) is given in parenthesis

Source	Female	Male	Unknown	Total
Longline	478 (48.0–126.0)	0 –	0 –	478
Museum collections	9 (31.5–67.2)	15 (22.8–49.4)	70 (11.8–47.8)	94

Maturation

Histological examination of ovaries revealed pre-vitellogenic or vitellogenic oocytes. Pre-vitellogenic oocytes (Fig. 5A) were 20 to 80 µm in diameter, were tightly packed in the ovary, had a large nuclear diameter (half to two-thirds the diameter of the oocyte), and had nucleoli distributed throughout the nucleoplasm. Oocytes in this stage were very similar to those described by Combs (1969) for *Brevoortia patronus* in Stages 2 and 3 and Moe (1969) for *Epinephelus morio* in Stage 1. Oocytes with a diameter >80 µm had clear spaces in the cytoplasm and the nucleoli were found at the periphery of the nucleus

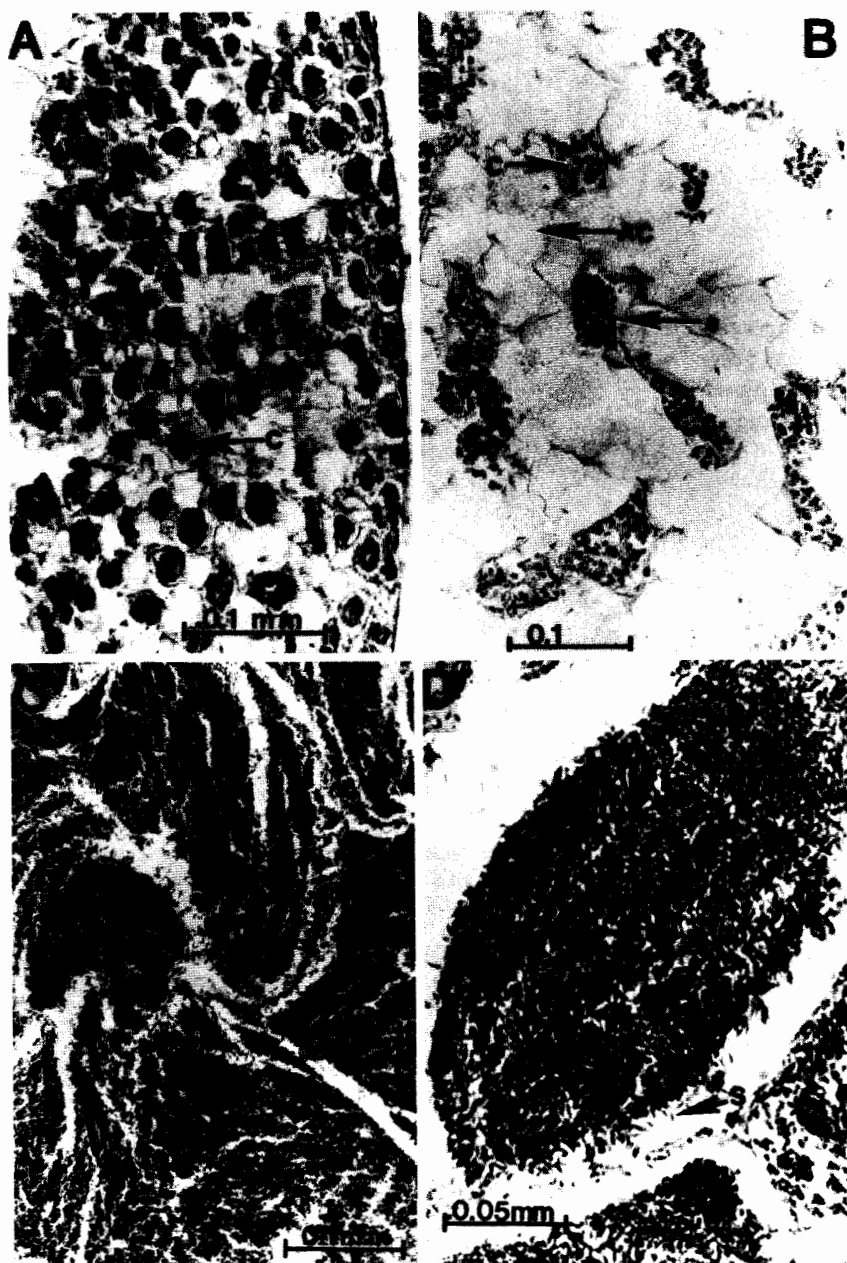


Fig. 6. *Conger oceanicus*. Sections of testes: A: Cross section through the testes of a 45 cm TL male showing tightly packed crypts of spermatocytes. Magnification 160 \times ; B: Cross section through the testes of a 41 cm TL male at a more advanced stage of development. The crypts of spermatocytes are now scattered in a matrix of adipose cells; C: Cross section of the testes of a possibly mature male (23 cm TL). The gonad is comprised of vesicles containing very small cells which may be spermatocytes or spermatids; D: Same section as C, higher magnification. AC: adipose cell; s: spermatocytes; C: crypt; S: spermatid

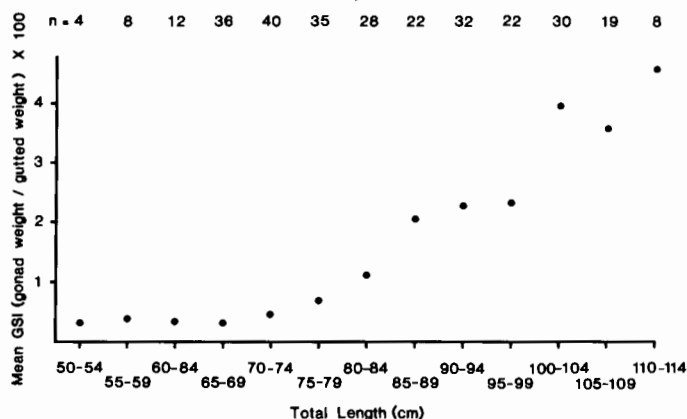


Fig. 7. *Conger oceanicus*. Mean gonosomatic index (GSI) for eels collected in the Mid-Atlantic Bight by longline

(Fig. 5 B). These oocytes were similar to Stage 4 of Combs (1969) and Stages 2 and 3 of Moe (1969) when vitellogenesis was occurring. The largest oocytes observed were 300 to 350 μ m in diameter and were still undergoing vitellogenesis.

The ovary became noticeably enlarged in most females 75 to 85 cm TL, and this was reflected in the increase in mean gonosomatic index (GSI) (Fig. 7) and mean maximum oocyte diameter (Fig. 8). Histologically, two events accompany this change: vitellogenesis begins in the oocytes and lipid material is deposited in the gonad as evidenced by the large clear adipose cells surrounding the oocytes (Fig. 5 B). No fully ripe ovaries as described by Combs (1969) or Moe (1969) were seen, nor were any observed in a post spawning condition, as described by Cau and Maconi (1984) for *Conger conger*.

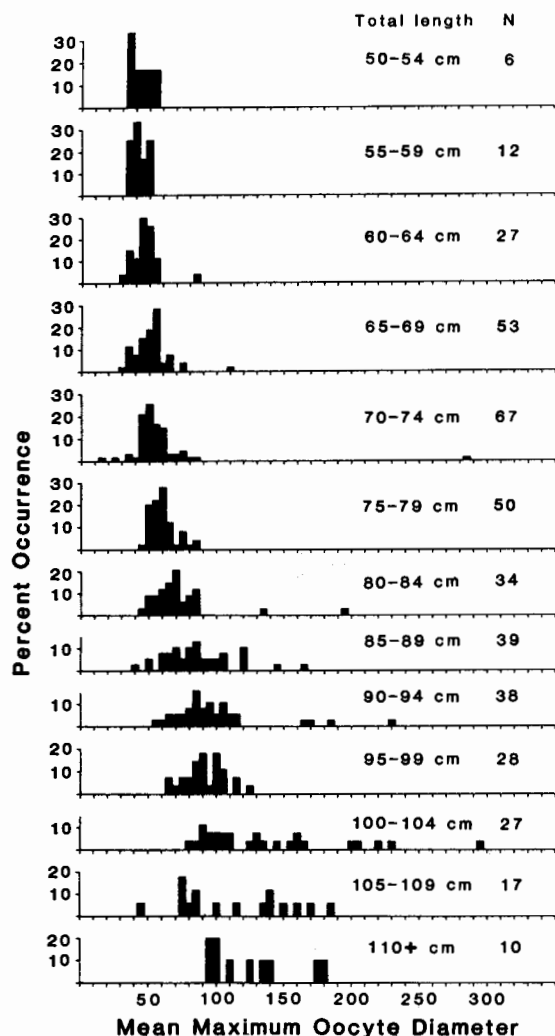


Fig. 8. *Conger oceanicus*. Frequency distributions of mean maximum oocyte diameter (μm) at 5 cm TL intervals for eels collected by longline

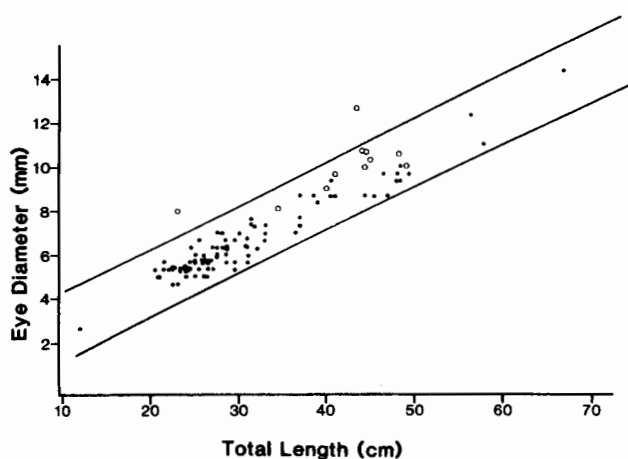


Fig. 9. *Conger oceanicus*. Regression of eye diameter (mm) on TL (mm) showing 95% confidence intervals for eels collected by trawling (female and indeterminate represented by filled circles and males by open circles) $n = 106$

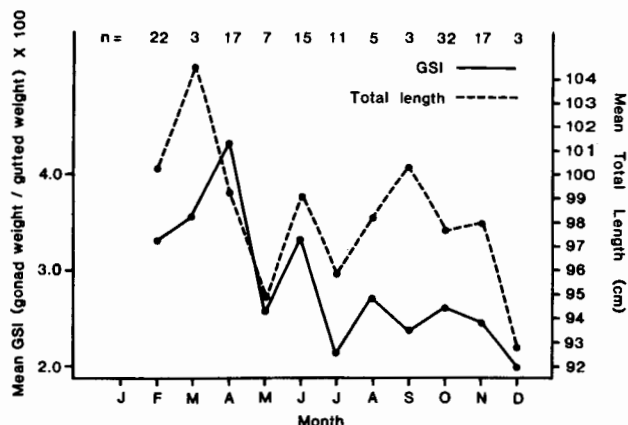


Fig. 10. *Conger oceanicus*. Mean gonosomatic index (GSI) and mean TL plotted at monthly intervals for individuals > 85 cm TL collected by longline

The testes, like the ovary, ranged in shape from thread-like to ribbonlike. Although the spermatocytes did not vary in size, there were differences in the microstructure of the testes (Fig. 6 A, B). Some testes had adipose tissue surrounding the crypts of spermatocytes (Fig. 6 B). If development of the testes follows the pattern seen in the ovary, then testes with adipose cells present may be more advanced than testes without.

Of the 15 males identified, all but one were in a similar stage of maturation, making it difficult to describe to what extent spermatogonia had developed. Since the cells were often smaller than the cells observed in undifferentiated individuals, it is likely that one or two divisions had occurred and that the cells were spermatocytes (Fig. 6 A, B). These cells match descriptions of spermatocytes of *Anguilla rostrata* (Dolan and Power 1976) and *A. anguilla* (Sinha and Jones 1966). One small (23 cm TL) male appeared to be close to maturity. This individual was collected in September at a depth of 95 m in Norfolk Submarine Canyon. The testes were large (33% of the body weight) and lobed. Histological examination of the testes revealed small, fusiform-shaped cells which could be spermatids or spermatozoa (Fig. 6 C, D). In addition, this individual had an eye diameter much larger than expected for an eel of its size (Fig. 9).

There was no evidence of spawning activity in the Mid-Atlantic Bight and southern New England waters since we found no mature females. Because females > 85 cm TL generally had high GSI and MMOD values (Figs. 7 and 8), individuals larger than 85 cm TL were examined for seasonal changes that might indicate when spawning occurs. The most mature females were found offshore during the late spring and early summer. There was a general trend of decreasing mean GSI from a high in late winter and spring to a low in the fall (Fig. 10) though GSI is clearly linked to TL. Also, in the March to April distribution of mean maximum oocyte diameters (Fig. 11), the greatest frequency of oocytes with diameters $> 200 \mu\text{m}$

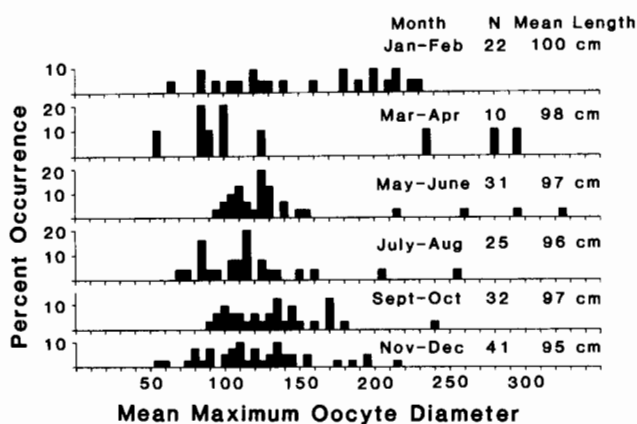


Fig. 11. *Conger oceanicus*. Bimonthly frequency distribution of mean maximum oocyte diameters (μm) for individuals >85 cm TL collected by longline

was observed. Individuals with these large oocytes were present until November to December when they disappeared.

Discussion

Distribution, size structure, and abundance

Conger oceanicus taken offshore by longline were clearly larger than those taken by trawling at predominantly inshore stations (Fig. 3). However, different types of gear were used, and thus differences in size structure observed between inshore and offshore regions may be a result of gear selectivity. Bigelow and Schroeder (1953) reported that the largest individuals they encountered were from offshore southern New England and New Jersey waters and they speculated that size and depth might be related. However, small eels (<50 cm TL) were taken by trawl at depths >200 m in Norfolk Submarine Canyon, indicating that they may be distributed across a wide depth range.

The seasonal abundance of conger eels taken offshore by longline was highest in winter and spring. Grimes et al. (1980) and Turner (1986) have observed this same pattern in catch per unit effort data for tilefish caught in the Mid-Atlantic Bight by longline, and Grimes et al. (1986) speculate that the tilefish population may concentrate in warm water pockets and thus be captured at a greater rate. Conger eels may also concentrate in warm-water pockets during the winter months.

Age and growth

Though other fish from the same offshore habitat, such as tilefish (Turner et al. 1983), have a definite annual ring pattern, the same cannot be said for female *Conger oceanicus*. Marginal increment analysis inconclusively suggests that rings were laid down during the winter

and/or spring. Because the temperature fluctuations encountered by conger eels collected offshore are small (9° to 14°C Dooley 1978, Grimes et al. 1986), seasonal changes in otolith structure may be less pronounced. *C. oceanicus* otoliths seem to be of marginal value as an aging structure. It may be useful to examine other bony structures such as vertebrae, the operculum, or fin rays for annuli.

Aging *Conger oceanicus* and back-calculating length at age was particularly difficult because the multiple banding pattern encountered was difficult to follow completely around the otolith section. Forst (1945) and Todd (1980) described this same pattern for *Anguilla anguilla* and *A. dieffenbachii* respectively, and consequently had similar difficulties. The percent of unreadable otoliths in this study (about 20%) was comparable to those reported in age and growth studies of *A. anguilla* (Sinha and Jones 1967) and *A. dieffenbachii* (Todd 1980).

Empirical length at age and mean back-calculated length at age were quite variable. Some of the variability, in addition to the problems described above, can be explained by the techniques used to calculate these values, using the highly variable otolith:total length relationship. Mean empirical length at age was calculated using individuals caught at different times of the year, so that length may vary by the time of year caught. However, since this variation in length is so extreme that it often includes the mean length for the age above and below any given age, some of this variation is likely to be natural. Similar variability has been reported for other eel species (Sinha and Jones 1967, Gray and Andrews 1971, Todd 1980).

Reproductive biology

Morphologically and histologically, gonads of *Conger oceanicus* resemble descriptions for *Anguilla anguilla*. One male conger eel with lobed testes was considered nearly mature. Testes of *A. anguilla* have also been described as lobed (Sinha and Jones 1966, Gray and Andrews 1970, Wenner and Musick 1974, Dolan and Power 1976, Todd 1980). Histologically, testes from conger eels were also very similar to descriptions of *Anguilla* spp. Because the gross structure of male and female gonads is so similar in small *Conger oceanicus* (<50 cm TL), sex must be determined histologically.

No males were taken by longline yet males and females were collected by trawl at inshore and offshore sites. The simplest explanation for the lack of males in the fishery is that males are too small to be caught by the longline. The largest male *Conger oceanicus* examined was 49 cm TL, the size of the smallest females taken by longline. The maximum size of migrating males may not overlap with the minimum size of migrating females as found in *Anguilla australis* (Todd 1980). Another explanation for the observed difference in size distributions could be that large males are not as prevalent at northern latitudes as females, since sampling occurred in the north-

ern part of the range. Vladykov (1966) reported a latitudinal gradient in sex distribution of *A. rostrata* along the east coast of North America.

Two stages of maturity were seen in female *Conger oceanicus*. The first was represented by: (1) a gonosomatic index of <1%; (2) oocytes in a pre-vitellogenic state; (3) little or no lipid material present in the ovary. The second stage had: (1) a higher gonosomatic index (1 to 4%); (2) larger oocytes that were undergoing vitellogenesis; (3) adipose cells in the ovary. Adipose cells in the gonad of *Anguilla anguilla* have been hypothesized to function as a site for energy storage preparatory to migration (Boetius and Boetius 1980).

Relative maturity in males was difficult to compare since only one male appeared mature. Besides having a large gonad in relation to body size and spermatids present, the eye diameter was larger than expected for an individual of its size. Vladykov (1973) and Wenner (1973) have correlated increasing eye diameter with increasing maturity in *Anguilla rostrata*.

This study suggests that female *Conger oceanicus* only spawn once and not in the Mid-Atlantic Bight or southern New England waters. No ripe or post-spawning *C. oceanicus*, as described for *C. conger* (Cau and Maconi 1984), were observed. The largest number of maturing females were seen offshore in spring and early summer, and not thereafter, suggesting that they left the area to spawn. These mature females had gonosomatic indices and mean maximum oocyte diameters similar to values for migrating *Anguilla rostrata* (Wenner and Musick 1974). Bigelow and Schroeder (1953) suggested that *C. oceanicus* ripens during summer and then moves offshore, but they gave no evidence for this pattern. The disappearance of almost mature individuals and the fact that Schmidt (1931) found the smallest leptocephali in the Sargasso Sea, supports his hypothesis that *C. oceanicus* undergo a spawning migration to the Sargasso Sea similar to that of *A. rostrata*.

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